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SEDIMENTATION NEAR THE CONFLUENCE OF THE MISSOURI AND NIOBRARA RIVERS 1954 TO 1990

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SECTION VII - SUMMARY OF RESULTS

1. Introduction

1.1. This study was conducted with the primary objective of compiling existing data related to the sedimentologic and geomorphologic characteristics of the Niobrara and Missouri Rivers in the vicinity of their confluence. No original data were collected during this study. The ultimate goal of the compilation is to provide a database that can be utilized to address concerns related to continued sediment deposition at the mouth of the Niobrara River. Potential consequences of delta development and growth at the confluence include loss of channel capacity, lateral channel destabilization resulting in increased bank erosion, increased overbank flooding, and increased water table elevations adjacent to the streams. Although this report provides an analysis of historic trends in the study reach, the analysis does not provide a forecast of future channel behavior. The historic trend analyses contained within this report constitute a database from which future trends could be predicted if such a study is warranted in the future.

1.2. The primary elements of the study include the evaluation of changes in gage height, channel geometry and sediment size distributions on the Niobrara River from the confluence with the Missouri River upstream approximately 14.5 miles, and on the main stem of the Missouri River from about 4.5 miles downstream to about 3.5 miles upstream of the confluence. Gage height trends within the study reach were evaluated by comparing stage/discharge relationships over a period of approximately 35 years at 2 Niobrara River stream gages and 3 Missouri River gages. The channel geometry analysis consisted of evaluating changes in the geometric characteristics of surveyed cross sections at a total of 33 ranges in the study area, 11 of which are located on the Missouri River and 22 on the Niobrara River. Hydraulic elements and parameters evaluated include channel width, mean channel depth, cross sectional area, mean bed elevation, and thalweg elevation. Bed sediment gradation data were utilized to evaluate sediment size distributions within the study reach.

1.3. A primary objective of this study is to document the effect of Lewis and Clark Lake and Fort Randall Dam releases on the geomorphologic characteristics of the study reach. Fort Randall Dam, located on the Missouri River 35 miles upstream of the Niobrara River confluence, was closed in 1952. Gavins Point Dam, located on the Missouri River 35 miles downstream of the Niobrara River confluence was closed in 1955. Since closure of the dams, large seasonal fluctuations in the Missouri River flows have been eliminated, reducing the ability of the Missouri River to transport sediment delivered by the Niobrara River downstream of the confluence. A large delta has formed at the confluence as a result of the reduced transport capacity of the Missouri River after dam closure.

2. Summary of Results

2.1. The primary results of this data compilation and trend evaluation are included as plates and tables within Appendices I through VI. Location maps and data resource availability tables are contained within Appendix I. Appendix II contains plots of rating curve trends. These plots contain stage/discharge relationships through time for 5 stream gages in the study reach. The channel geometry

analysis is based upon plotted channel cross sections as well as hydraulic element and hydraulic parameter trends. The plotted cross sections are contained within Appendix III. Most of the ranges evaluated are represented by a series of plots, each of which contain 3 to 4 cross sections. The cross section from the original survey is repeated on each plot to maintain a general reference baseline for ease of comparison. Hydraulic element trends are presented in Appendix IV. The hydraulic element analysis consisted of evaluating changes in channel width, mean channel depth, and cross sectional area with elevation for each cross sections. Hydraulic parameter trends are contained within Appendix IV. The hydraulic parameters were evaluated along the length of the study reach in reference to specific reference planes determined for each cross section. Bed material gradation trends are presented in Appendix V, and groundwater well hydrographs are presented in Appendix VI.

2.2. The objective of the gage trend analysis is to compare sequential rating curves to determine the variation in stage for specific discharges through time. The gage trends developed in this study are presented in Plates II.1 through II.5 in Appendix II. The general trend depicted by the Niobrara River stage/discharge relationships is an increase in stage over the period of record characterized by rapid increases followed by short periods of relative stability. The increasing stage on the Niobrara River is likely the result of continued growth of the Niobrara River delta during periods of significant sediment delivery from the Niobrara River coupled with relatively low flows on the Missouri River. The most rapid increase in stage elevation at these two gages during the period for which rating curves are available occurred between 1974 and 1985.

2.3. The two Missouri River gages that are located within a few miles of the Niobrara River confluence are characterized by a trend of increasing stage elevation. A marked increase in stage elevation occurred at these two gage sites between 1977 and 1986, similar to the Niobrara River gages. In addition, rapid rise in stage elevation occurred on the Missouri River at Niobrara between 1957 and 1960. The Missouri River at Greenwood gage, located approximately 20 miles upstream of the Niobrara River confluence, shows no consistent change in stage with time. The gage trend analysis indicates that the study reach has been characterized by a general increase in stage through time for a given discharge. This increase has been most pronounced at the confluence of the Niobrara River and Missouri Rivers, indicating that the rise in stage can be attributed to deposition of Niobrara River sediment at the confluence.

2.4. Plates IV.1 through IV.96 contain hydraulic element plots for each of the ranges considered in this study. The plots depict general channel infilling along the study reach. Channel area has been lost at each of the ranges due to sediment deposition in the channel bed. Bank erosion has occurred locally. In general, delta development and growth has been characterized by general aggradation and reduction of mean channel depth and cross sectional area with minor associated bank erosion and channel widening. Channel infilling on the Niobrara River extends from the mouth upstream to at least RM 9.

2.5. Hydraulic parameter plots contained as Plates IV.97 through IV.106 show spatial and temporal trends in evaluated parameters along the study reach.

2.6. On the Niobrara River, the thalweg profile shows a slight increase in thalweg elevation

between 1956 and 1983 at RM 12 near the Verdel gage which corroborates the gage trend at that location (Plate IV.97). Downstream of RM 7.0, the profiles show a significant increase in thalweg elevation through time from RM 7.0 downstream to the mouth. The average bed elevation profile displays much less variability than the thalweg profile (Plate IV.98). From 1956 to 1983, there has been a net increase in average bed elevation of approximately 3 feet between RM 5.0 and RM 7.0, and an increase of approximately 5 feet at the mouth of the Niobrara River. Channel topwidth has not changed in any consistent manner through time (Plate IV.99). The data indicate that channel topwidth increases gradually downstream through the study reach to approximately RM 1.0, at which point the channel abruptly narrows. Similar to channel width, channel depth increases in the downstream direction for a given year (Plate IV.100). Through time, there has been a consistent trend of depth reduction throughout the study reach. This depth reduction ranges from approximately 0.3 feet upstream of RM 9 between 1956 and 1975 to over 4 feet at the mouth of the river between 1956 and 1983. The trend in cross sectional area is very similar to that of channel depth (Plate VI.101). The most dramatic reduction in cross sectional area for the available data has occurred downstream of RM 9.0.

2.7. On the Missouri River, the thalweg profiles are extremely erratic in nature (Plate IV.102). There is no apparent trend of rising or lowering thalweg elevation through time on the Missouri River study reach. In contrast, the average bed elevation profiles show a general increase between 1954 and 1984 (Plate IV.103). Upstream of the Niobrara River confluence, the rise has averaged approximately 2 feet between 1954 and 1985. For the same time period downstream of the confluence, the rise in average bed elevation has ranged between 2 and 6 feet. This probably reflects downstream reworking of Niobrara River sediment by the Missouri River and may reflect some additional growth of the Niobrara River delta. Channel topwidths on the Missouri River study reach are highly variably spatially, but have remained relatively constant through time (Plate IV.104). There has been an overall reduction in channel depth of approximately 3 to 5 feet downstream of the confluence and 2 feet upstream of the confluence between 1954 and 1984. Channel area trends depict a similar reduction in cross sectional area. Channel cross section plots show that some widening has occurred at Missouri River Ranges 883.9 and 884.4 (Plates 111.49 to 111.54).

2.8. Bed sediment gradation plots indicate that the dominant sediment size through the study reach for both the Missouri and Niobrara Rivers is sand. The fine fraction of Missouri River bed sediment is slightly coarsened by Niobrara River input, however the coarsest fraction is relatively unaffected (Plates V.1 through V.10).

2.9. Groundwater piezometer hydrographs from the Niobrara townsite depict a general increase in piezometric surface elevation for the period of record which extends from 1961 to 1986. Several of the hydrographs display a period of piezometric surface stability between 1972 and 1980. The increase in piezometric surface elevations at these well sites has been on the order of 3 to 5 feet. The groundwater wells located adjacent to the Missouri River upstream of the Niobrara River confluence display a continual decline in piezometric surface elevation of approximately 3 feet between 1983 and 1991. The wells located

on the Niobrara River between RM 6 and RM 14 show distinct seasonal variation in the elevation at the piezometric surface. Two wells show a general decrease in piezometric surface elevation of about 2 feet between 1983 and 1991. This decline clearly overprints the seasonal variation of ground water table elevations.